

The Short-Term Effects of Nuclear War: The Medical Legacy of Hiroshima and Nagasaki¹

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INTRODUCTION

The medical aftermath of the bombings of Hiroshima and Nagasaki in 1945 is an unpleasant subject, one difficult for even physicians to dwell upon. Nevertheless, an understanding of the medical consequences of nuclear war must begin with the historical record—what experience has shown us is true. In addition, physicians and other health-care workers are obliged to keep before the general public the medical facts about nuclear war in 1945, so that knowledge may lead to understanding, and hopefully prevention, in our own time and beyond.

HIROSHIMA AND NAGASAKI

Even in the late spring of 1945, there was considerable discussion among U.S. military planners as to which city should be targeted for the first nuclear weapon to be exploded over a general population (16). The decision had long since been made that such a devastating military event would be necessary to bring the war in the Pacific to an end. The concept of a demonstration explosion over a non-populated area, such as Mount Fuji, had been rejected on the grounds that the Japanese were unlikely to surrender after such an event. A strong argument had been made to bomb Kyoto, but this was rejected by Secretary of War Stimson, in spite of the powerful argument that Kyoto was a large enough city to provide adequate demonstration of American nuclear capability. Stimson argued successfully that Kyoto was simply too important an historical and spiritual center to be devastated (16).

The cities chosen for nuclear attack, Hiroshima and Nagasaki, were both medium-sized municipalities with small clusters of military forces in August of 1945. Throughout the war, the inland sea had been a major staging area for the Japanese naval fleet, and Hiroshima was its main port.

The nuclear weapon that was exploded over Hiroshima had the blast power of 11.5 kilotons of TNT. Approximately half the radiation energy released was in the form of neutron rays, which are particularly damaging to biological tissue. The Nagasaki weapon exploded with the firepower of 22.5 kilotons of TNT, but a

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with a lower percentage of its radiation energy was in the form of neutron rays. The weapon detonated approximately 600 meters into the atmosphere, resulting in a relatively more immediate blast effect and relatively less fallout. During ground level explosions, more earth and other particulate matter is rendered radioactive, lifted up into the typical "mushroom cloud," and blown downstream in now-familiar fallout patterns.

Hiroshima before the atomic bombing on August 6, 1945, was a sophisticated city with a complex mix of industrial and residential structures (Fig. 1). The atomic bomb which exploded at 0815 hr on August 6, 1945, changed all that forever. An area reconnaissance photograph taken some weeks after the bombing reveals the obliteration of all recognizable city characteristics, except the street grid previously obscured by the landmarks of civilization (Fig. 2). At the time of the bombing, the city was arrayed around the many branches of the River Ota in a combination of steel-reinforced concrete buildings and residen-

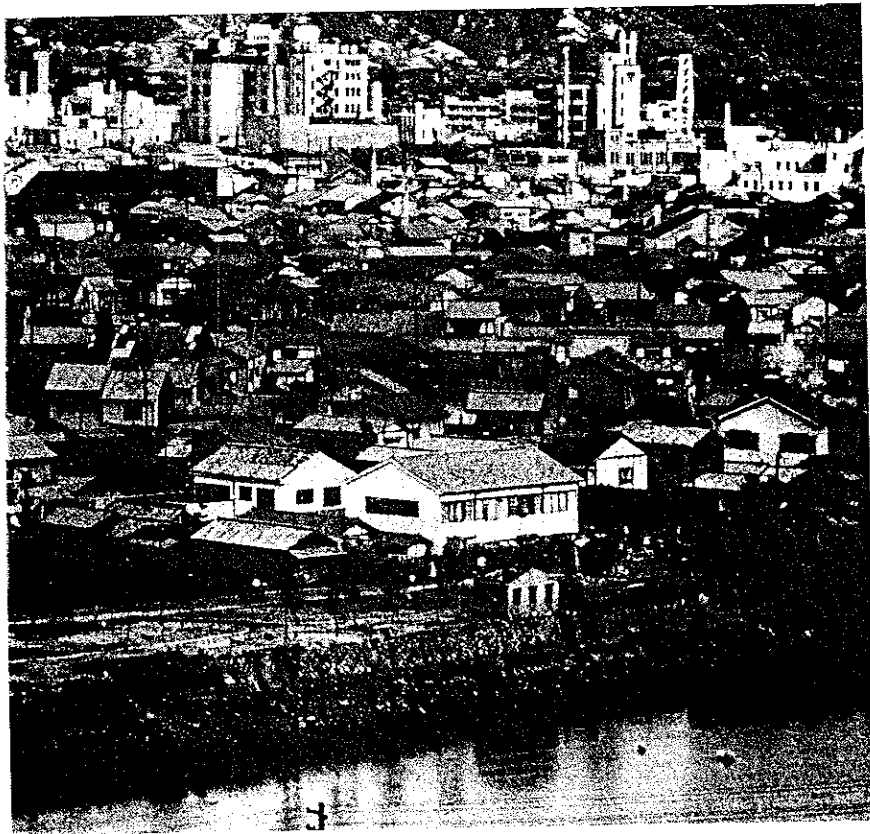


FIG. 1 Hiroshima—before attack. (Photo by Koichi Sato)

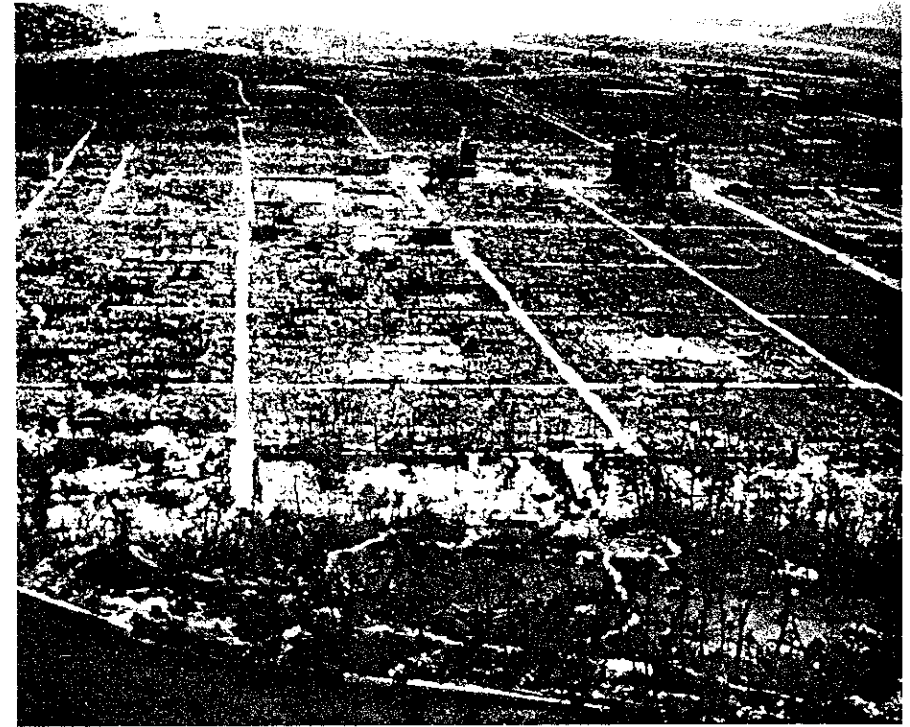


FIG. 2 Hiroshima—after attack (Photo by Robert Lewis)

tial structures made of wood and stucco. Because of the timing of the attack and the presence of prevailing winds, an enormous firestorm swept through the city, obliterating whatever the immediate blast effect had not.

In Nagasaki, although the bomb was not as direct a hit as the one exploded over Hiroshima, the devastation was almost equally severe. There are many estimates of the immediate civilian casualties following the nuclear attacks on Hiroshima and Nagasaki, and the estimates tend to vary depending on the political orientation of the authors. However, Oughterson and Warren (12) provided a relatively conservative but realistic estimate, which indicates that approximately 100,000 people were killed outright in the two cities (Table 1). By the end of 1945, 4 months following the nuclear explosion, that number had essentially doubled. Therefore, most authorities agree that more than 200,000 people died as a result of the immediate and subacute effects of the nuclear explosions.

It has been estimated that the intensity of the heat generated by the nuclear explosions was between 3,000 and 4,000°C (5,400–7,200°F) at ground level near the hypocenters (3). This enormous level of heat was sufficient to vaporize people and objects. In fact, the shadows of many citizens were frozen in time on side-

TABLE I
ESTIMATED ATOMIC BOMB CIVILIAN CASUALTIES

City	Population	Killed	%	Injured	%
Hiroshima	255,200	64,600	25.3	72,200	28.3
Nagasaki	195,300	39,000	20.0	25,000	12.8

Source Ref (2)

walks and bridges, their bodies before extinction protecting the pavement from the full force of the heat (Fig. 3).

The medical aftermath of Hiroshima and Nagasaki can be divided into three broad temporal segments: the immediate effects, the subacute or "shelter" effects, and the long-term effects.



FIG. 3. Top: Shadow of person on Bantai Bridge outlined in chalk. The asphalt has been darkened by exposure to the flash. Farther down the bridge can be seen the outlines of a cart and the person drawing it. Bottom: Individual standing on the shadow and in the position of the person vaporized at the moment of explosion. Source Ref. (10)

During the first hour following the devastation, those who were not killed outright suffered primarily from flash burns and from trauma, both from the blast itself and from shrapnel. In addition, the downward force of the air burst explosion trapped many people under buildings, where they succumbed, since relief help was not available.

Medical and surgical institutions in both cities were devastated (Fig. 4). At Nagasaki Medical University, one of the premier medical schools in Japan at that time, 1,100 health-care workers were on the premises when the bomb exploded at 11:02 hr on August 9, 1945. Of those present, 892 were killed outright or died within the first day (4) (Table 2).

Therefore, in both cities, those who had survived the first hour or two after the explosion could only be huddled together in amorphous groups awaiting medical attention, which for the most part could not come (Fig. 5). Many of the hibakusha (survivors) remember this experience quite vividly and have written movingly about their memory of the deprivation of medical help after the bombing (6). Since both detonations occurred during the morning hours, many schoolchildren



FIG. 4. Nagasaki Medical University in ruins (mid-October 1945) (Photo by Shaigeo Hayashi.) Source Ref. (4)

TABLE 2
DEATHS AMONG NAGASAKI MEDICAL UNIVERSITY PERSONNEL

Staff	Teaching	President; professors	17	} 42
		Assistant professors	10	
		Lecturers, assistants, others	15	
	Administrative	Supervisors, secretaries	206	206
Students	Nursing	Nurses, midwives	51	} 109
		Student nurses, midwives	58	
	Medicine	Medical students	194	} 535
		Special medical students	305	
		Special pharmacy students	36	
Pharmacy				
	Total			892

Source Ref. (4)

were affected by flying glass and other particulate objects travelling at extremely high rates of speed because of the force of the nuclear explosion (Fig. 6). However, the image from Hiroshima that remains is that of the fire storm which ravaged the city throughout the day. Depending on where survivors had been standing and the degree of shielding they had received from surrounding structures, flash burns were a common and especially painful problem during the acute phase (Fig. 7). The typical flash or "profile" burns were caused by the instantaneous nature of the sudden bursts of heat. The intensity of the heat and light generated by the explosions also cast bizarre patterns on human skin, since dark areas of clothing transmitted the light more readily than did lighter areas on the same garment (Fig. 8).

Those burns that did heal often formed keloids, which took months or years to resolve slightly, but which in many cases have lingered to the present as psychological as well as physical scars of the devastation (Fig. 9).

Another physical effect with psychological ramifications was the phenomenon known as "black rain." Although the sky had been bright and relatively cloudless at the time of the explosion at 0815 hr in Hiroshima, by later morning, storm clouds had begun to form, and they were blackened by the soot from fires which raged throughout the city. When it began to rain later in the morning, the rain fell as a dark, oily, and seemingly clotting liquid. It stained not only buildings but also people, especially those early entrants who had come back into the city in a futile search for loved ones.

Although there is much dispute regarding the degree of radiation, if any, in the black rain, the subject has remained a psychological problem for many hibakusha and their families. It is also the central event in a moving novel by Ibuse (5).

The Japanese survivors of Hiroshima and Nagasaki have coined the phrase "A-bomb disease." Its subacute phase is not a single disease, but rather a syndrome consisting of epilation, purpura, and death amid lassitude and weakness. Weeks or even months after the atomic bombings of the two cities, women



FIG 5 Upper: A nurse ministering to burned and injured patients, August 9, 1945. The scene is under tentage at the Hiroshima No. 2 Army Hospital at Motomachi. This was staffed by the Second Provisional Fukuoka Army Hospital. Lower: Burned and injured patients (Photos by Nishina.) Source Ref (10)

standing in front of their mirrors combing their hair would be stunned to have it come out in great clumps (Fig. 10). This gave hibakusha the impression that there was simply no outrunning the medical effects of the bombings, and that there was indeed a "poison" in the marrow working its evil over time.

The Atomic Bomb Casualty Commission (ABCC) was founded by the governments of the United States and Japan in the late 1940s in an attempt to draw medical lessons from the atomic bombings of Hiroshima and Nagasaki. Although a full discussion of the delayed effects of nuclear war is beyond the scope of this paper, the medical story of Hiroshima and Nagasaki is incomplete without a brief



FIG. 6. Incised wounds by glass splinters. Many A-bomb survivors suffered severe injury from glass fragments with some containing these pieces to the present day (Courtesy of Masao Shiotsuki)



FIG. 7. "Profile burns" of legs. Only the directly exposed skin has been burned. There is evidence of keloid formation. The patient was a soldier in the military compound approximately 900 m from the hypocenter. Source: Ref. (10).

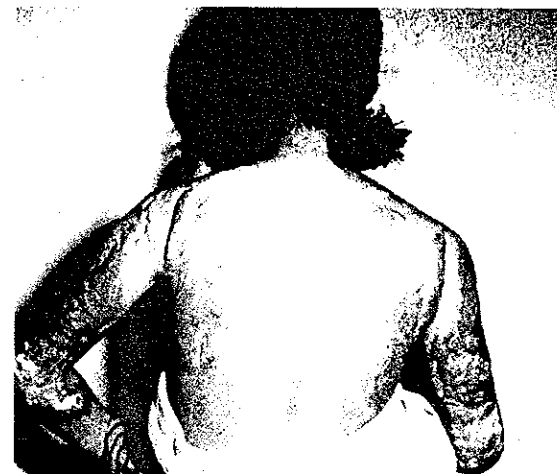


FIG. 8. Upper: Flash burn in acute stage. The upper portion of the body was unclothed and suffered a sharply outlined profile burn. Patient was probably within 1,000 m of blast hypocenter. The buttocks and thighs were burned through clothing, but the waist was protected by a multilayered sash. Lower: Keloids of skin in 21-year-old woman, at 1,600 m, seen in early November 1945. Some protection came by means of blouse and straps of undergarment. Source: Ref. (10).

recounting of the key findings of the ABCC (renamed Radiation Effects Research Foundation in the mid-1970s). The most important finding of the ABCC has been the striking increase in leukemia incidence in both cities. In Hiroshima, the peak year for leukemia mortality was 1952, 7 years after the nuclear explosion. This has reinforced in the minds of hibakusha their already strong feeling that the medical effects of their nuclear exposure would remain latent for a while but eventually become manifest. A highly respected Japanese epidemiologist, who as a young man was 1 km from the explosion in Hiroshima, has told the author that whenever he brushes his teeth and notes gingival bleeding he is convinced that the leukemia has finally struck. Lifton has written movingly on the "death in life" phenomenon among A-bomb survivors (11).

The relative risk of leukemia was much higher among children than among similarly irradiated adults. In the period 1950-1966, surviving Hiroshima resi-



FIG 9 Keloids formation. The photo on the right was taken several years after that on the left.

Patients exposed to 100 rad or more had leukemia rates 5.4 times higher than controls if they were age 40 years or older, but 15 times higher if they were under age 5. Tissue that replicates quickly is more radiosensitive; children are more sensitive than adults, and embryos are more sensitive than children (4).

In terms of overall cancer mortality, the increase among heavily irradiated Hiroshima and Nagasaki survivors is statistically overwhelming—18 times higher than controls (2).

There was also a dose-related increase in somatic chromosome abnormalities in the two cities, more marked in Hiroshima, perhaps as a result of the higher neutron composition of the radiation released there. Children under 12 years old when exposed to 100 rad or more of whole body radiation grew to a shorter adult height (2–4 cm) than did their nonexposed or less-exposed contemporaries (4).

LESSONS FROM NUCLEAR WAR, 1945

When one speaks of Hiroshima and Nagasaki, it is necessary to grasp the reality that they represent a parable rather than a quantitative blueprint for our future. The weapons in today's nuclear arsenals dwarf the primitive devices that devastated the two Japanese cities 41 years ago. For instance, a single 20-megaton weapon would produce near total death and destruction in a radius from Hiroshima that could barely be traversed in 1 hr on an efficient Japanese train.

The United States and the Soviet Union, possessing approximately 95% of the world's 55,000 nuclear weapons, have it within their capability to destroy each other many times over (Figs. 11 and 12). One bomber in the United States' stra-

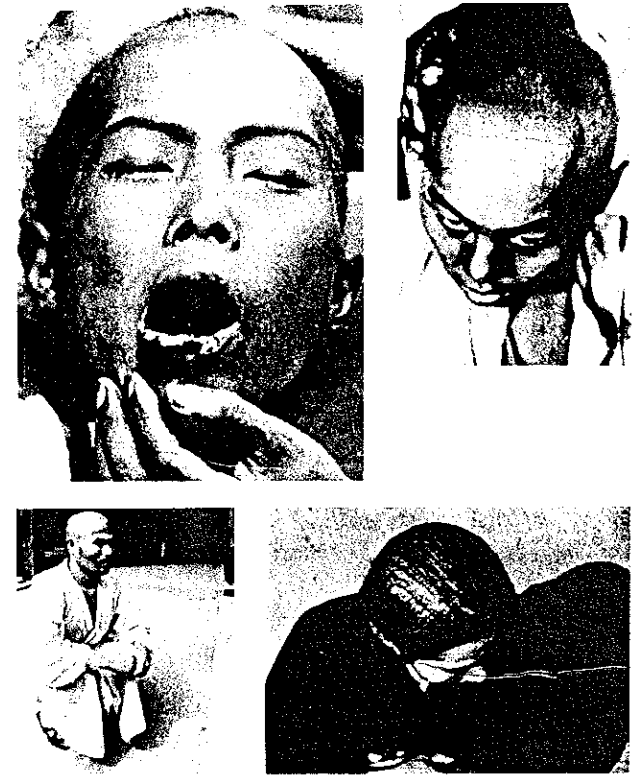


FIG 10. Top left: Patient showing dermatitis and epilation. Distance not recorded but was probably within 1,000 m (First Military Hospital File). Top right: Epilation and petechiae in patient exposed within the military compound, at 1,000 m. Patient died on August 31, 1945 when the white count had fallen to 45. Lower left: Epilation, which had begun on August 20, as seen on October 25, 1945. Patient was at Ujina Hospital. He had been indoors on the second story of a two-story Japanese building at 600–700 m. Lower right: Epilation in middle-aged woman. Patient was at Ujina outpatient clinic. Partial regrowth of hair began in late October 1945. Source: Ref (10).

tegic fleet can produce 100 Hiroshimas. One SS-18 Soviet strategic missile can produce 152 Hiroshimas. One Poseidon submarine in either nation's fleet could destroy most major cities in the respective "enemy" country.

Humankind, despite its propensity for belligerence, has never experienced in all its wars anything approximating the scope of death that would result from nuclear war waged today. It has been estimated that 140 million Americans and 113 million Soviets would die in a nuclear war (Fig. 13). Most would never see a physician or a health-care worker, since as in Hiroshima, 90% of all such helping personnel would be killed outright (14). Those who did survive would have no medical tools at their disposal—no uncontaminated supplies, instruments, or even water.

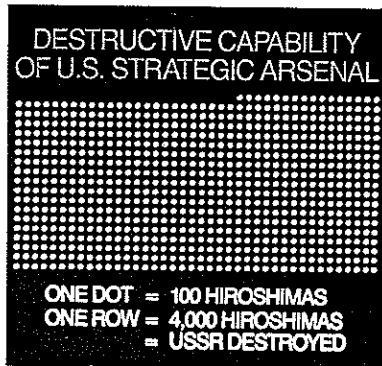


FIGURE 11

Physicians for Social Responsibility (PSR) and the International Physicians for the Prevention of Nuclear War (IPPNW) have been attempting to get these facts before the American people by bringing matters closer to home. As early as 1962, PSR estimated the medical devastation that would result from a 1-megaton explosion over major cities such as Boston and New York (9, 14). It is important to inform the general public that nuclear war cannot be contemplated because there is no place to hide. Thus, evacuation schemes and nuclear civil defense have been characterized as escapist and dangerous fantasies.

Of course, it has been necessary to show the immediate medical effects of nuclear war not only to those of us who reside in the West, but also to our Soviet counterparts. In fact, Ruth Sivard has coined the fictional city "Moscington" and graphically displayed the effects of a 1-megaton bomb on each capital city (15). Superpower leaders have been put on notice that the complete destruction of governing capability in each country's capital would result.

In June of 1982, three U.S. and three Soviet physicians appeared on Soviet television in an unprecedented and uncensored broadcast carried on several oc-

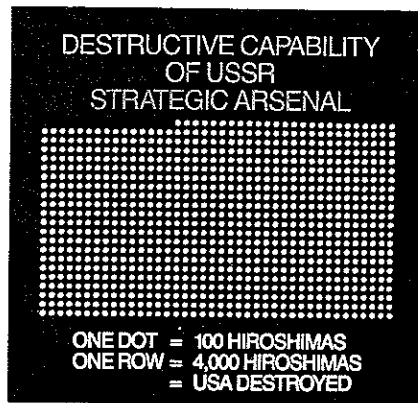


FIGURE 12

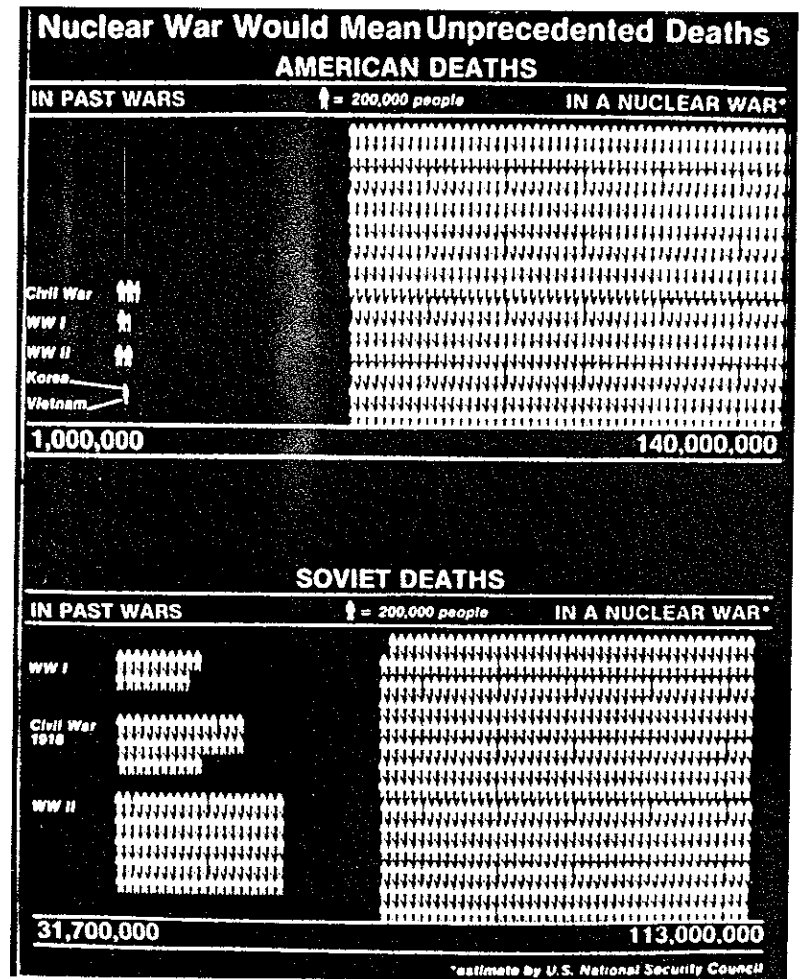


FIG 13 Source: Nuclear War Graphics Project Slide V 45

casions to a total of 100 million people in the Soviet Union. Soviet television viewers were warned that there was no surviving a nuclear war. They heard their own Soviet physicians agree that in the event of nuclear war, civil defense would have nothing to offer, and they were told that enormous amounts of money were being wasted in a mindless arms race. However, the highlight of the medical message was the argument by physicians from the East and the West that medicine simply had no capacity for coping with the devastation that would result from nuclear war. On the Moscow telecast, it was made clear to the Soviet audience, as it has been to audiences in the West, that even a single 1-megaton explosion over any world capital would result in more serious burn injuries than could be handled by the entire world medical community.

Relatively conservative organizations such as the American Medical Association have stated that "no adequate medical response is possible" (1). New data published recently by the Institute of Medicine (6) and by Leaf (8) indicate that previous predictions of the early and subacute effects of nuclear war, as well as more delayed effects, have underestimated the problem.

As A. Relman (editor of *The New England Journal of Medicine*) has recently stated, these medical arguments remain most convincing if they are put forth in a nonpolitical atmosphere and in general terms which people of all political persuasions can recognize as intrinsically correct (13).

CONCLUSION

The medical legacy of Hiroshima and Nagasaki is a distressing but important beacon for the future and a spur to action in the present. Indeed, our children and the world's children are being forced to mature in the shadow of the atomic bomb. Physicians around the world need to put aside partisan political beliefs and pledges to educate objectively their fellow physicians and the general public. Veril Liebow, one of the first U.S. physicians to work in Hiroshima after the bombing, stated it well more than a decade ago: The purpose of retelling this medical history is to see to it that "the evil of which it tells never comes back" (10).

As Bernard Lown, co-president of the IPPNW, has urged on more than one occasion, the work is difficult, but "think of what we win when we win." We win not only the sanity and survival of our children but also the preservation of this beautiful planet:

Treat the earth well
It was not given to you by your parents
It was loaned to you by your children

—Kenyan proverb

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